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(54) PULSE TRAIN GENERATING AND SELECTION APPARATUS

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The invention consists in pulse train generating and selection apparatus suitable for use in a telecommunication exchange system for passing data characteristic of a calling line to a selected called line, and including common pulse generator means (12) for producing a plurality of pulse trains, each train representing one possible item of said data, and further means (14, 16, 18, 20, 42, 46) including a plurality of selection units (42+46), for association with respective calling lines, associated with the generator means so that each unit when operated can automatically select a particular predetermined sequence of said pulse trains, which is characteristic of that unit, in order thus to be said data characteristic of the respective calling line.

The bracketted references denote examples of the relevant features in the accompanying drawings.

The features of the appended claims 2 to 20 are exemplified in the embodiments described below with reference to the accompanying drawings.

The embodiments described below relate to apparatus for use in a telephone system and more specifically to a completely electronic device for automatically transmitting information from a calling telephone line to a called telephone line.

It would often be advantageous to permit the transmission of information from a calling telephone line to a called telephone line such as for example when the called tele-

[*Price 25p*]

skilled in the art.

For instance, such systems could be particularly beneficial in a variety of businesses, particularly small business concerns which presently employ answering services and the like. A system of this type connected to a print out mechanism could be employed in an entire telephone exchange or network of exchanges to provide a record of every telephone call made to each and every called subscriber. This record could include not only the number of the calling party, but also a designation of the type of telephone service from which the call is placed, e.g., whether the call is placed from a public telephone booth, from a business office, from a private home, or any other type of telephone service.

Systems of this nature could also be extremely beneficial in the field of criminology and law enforcement activities designed to protect citizens against kidnapping, extortion, etc. Finally such systems could represent a convenience feature that many persons would desire and appreciate from a telephone service, irrespective of the business or social benefit derived from such a system.

The embodiments described below provide completely electronic apparatus for transmitting such information.

They provide an entirely electronic transmitting apparatus for transmitting pulse coded information over telephone lines wherein a large portion of the necessary electronic apparatus may be simultaneously

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(54) PULSE TRAIN GENERATING AND SELECTION APPARATUS

(71) I, THEODORE PARASKEVAKOS, a Greek citizen, of 61 Stadiou Str. - Athens (141) Greece, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to pulse train generating and selection apparatus.

The invention consists in pulse train generating and selection apparatus suitable for use in a telecommunication exchange system for passing data characteristic of a calling line to a selected called line, and including common pulse generator means (12) for producing a plurality of pulse trains, each train representing one possible item of said data, and further means (14, 16, 18, 20, 42, 46) including a plurality of selection units (42+46), for association with respective calling lines, associated with the generator means so that each unit when operated can automatically select a particular predetermined sequence of said pulse trains, which is characteristic of that unit, in order thus to be said data characteristic of the respective calling line.

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The embodiments described below relate to apparatus for use in a telephone system and more specifically to a completely electronic device for automatically transmitting information from a calling telephone line to a called telephone line.

It would often be advantageous to permit the transmission of information from a calling telephone line to a called telephone line such as for example when the called telephone is either busy or unanswered. If the transmitted information corresponds to a calling telephone number and if appropriate recording apparatus were included at the called telephone site, then it would be possible for the calling party to automatically leave a record of their telephone number with the called party. Other advantageous uses for such transmission of information may be readily called to mind by those skilled in the art.

For instance, such systems could be particularly beneficial in a variety of businesses, particularly small business concerns which presently employ answering services and the like. A system of this type connected to a print out mechanism could be employed in an entire telephone exchange or network of exchanges to provide a record of every telephone call made to each and every called subscriber. This record could include not only the number of the calling party, but also a designation of the type of telephone service from which the call is placed, e.g., whether the call is placed from a public telephone booth, from a business office, from a private home, or any other type of telephone service.

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They provide an entirely electronic transmitting apparatus for transmitting pulse coded information over telephone lines wherein a large portion of the necessary electronic apparatus may be simultaneously

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utilized by a large number of telephone lines thus reducing the necessary expense and complication of the resulting electronic circuitry.

They provide an entirely electronic apparatus for repetitively and serially generating groups of electrical pulses sequentially representing the ordinal places or digits of a predetermined number such as a telephone number for transmission on any one of a plurality of telephone lines.

They are suitable for use with a recording device at the called telephone site, for example as forming the subject of my co-pending application No. 12479/71 (Serial No. 1362411). Other recording systems known in the art and suitable for use with these embodiments require the interruption of the telephone circuit in a particular way or the transmission of a series of coded pulses over the telephone circuit to the recording device at the called telephone site.

These embodiments provide apparatus for generating a series of pulse trains for transmission to the called telephone site. Each of the pulse trains within the series will contain a number of pulses corresponding to the value of a particular digit of a predetermined number such as the telephone number of the calling telephone. If the pulse trains are properly chosen and sequentially transmitted to represent corresponding sequential digits of a predetermined telephone number then this series of pulse trains may be properly interpreted and recorded at the called telephone site to provide the necessary information.

Means for synchronizing the transmitting and receiving devices may also be included in the form of distinct synchronizing signals transmitted along with the pulse trains or a more subtle device may be employed such as ensures that each of the pulse trains ends at a particular predetermined and common point irrespective of the value of the particular digit being transmitted, or, conversely, such as ensures that each of the pulse trains starts at a particular time irrespective of the particular digit value. Of course, other synchronizing schemes may also be employed such as merely leaving an abnormally long time span between each of the individual pulse trains.

In any event, the receiving site must be able to differentiate each of the pulse trains, one from the other, and then to interpret the number of pulses contained in each of the sequentially transmitted pulse trains as representing a respective one of the ordinal place values of a predetermined number transmitted from the calling site.

Reference will now be made by way of example to the accompanying drawings in which like reference numerals denote like elements in each of the several Figures and in which:

FIGURE 1 is a block diagram of an exemplary embodiment of an overall system incorporating this invention;

FIGURE 2 is a graph of several electrical waveforms present at selected points in the system of FIGURE 1;

FIGURE 3 is a more detailed block diagram of an exemplary embodiment of an electronic pulse number generator which may be used in the system of FIGURE 1;

FIGURE 4 is a more detailed block diagram of an exemplary driver starting unit, counter and ordinal timing control unit (hereinafter called a priority determining unit) which may be utilized in the system of FIGURE 1;

FIGURE 5 is a more detailed block diagram of an exemplary embodiment for a start/stop control and for an output unit for a single telephone line in the system of FIGURE 1;

FIGURE 6 is an electrical circuit diagram detailing typical exemplary circuits which may be used in the blocks shown in FIGURE 3;

FIGURE 7 is a detailed circuit diagram for a typical exemplary circuit which may be used in the blocks shown for the driver starting unit in FIGURE 4;

FIGURE 8 is a detailed electrical circuit diagram for a typical exemplary circuit which may be used in the blocks shown in the priority determining unit in FIGURE 4, and

FIGURE 9 is a detailed electrical circuit of a typical exemplary circuit which may be used in the blocks shown for the output unit in FIGURE 5.

Referring now to the drawings and more specifically to the exemplary system shown in FIGURE 1, the apparatus to the left of dotted line 10 may be shared or commonly used by a great number (at least as many as 10,000) of individual calling and called telephone circuits. The apparatus to the right of dotted line 10 comprises a separate start/stop control unit 42 and an output unit 46 for each telephone circuit serviced in common by the apparatus to the left of dotted line 10.

As shown in FIGURE 1, the shared apparatus to the left of dotted line 10 comprises an electronic pulse number generator 12, a driver starting unit 14, a clock 16, a counter 18, and a digit priority determining unit 20 whose function is explained below. All of this apparatus operates in a continuous repetitive manner and is driven by clock pulses from a common clock 16.

In response to a "start" signal on line 22 from driver starting unit 14, number generator 12 responds at the next clock pulse by producing an output pulse at terminal 12, but not at terminals 1 to 11. On the very

next subsequent clock pulse, number generator 12 produces output pulses at both terminals 11 and 12 but not at terminals 1 to 10. Similarly, one more output terminal begins to function with each of the next succeeding clock pulses until, on the twelfth clock pulse (counted from the start signal on line 22), all terminals 1 to 12 have an output pulse appearing thereon. Thus, the number generator 12 simultaneously produces a plurality of output pulse trains (a separate pulse train on each of the terminals 1 to 12), each pulse train representing one possible value for any particular digit of a number. For instance, the value of a digit 9 would be represented by the output pulse train from terminal 9 since that pulse train would comprise 9 pulses. Similarly, the digit value 8 would be represented by the pulse train at terminal 8 and the digit value 1 would be represented by the pulse train at terminal 1 comprising only 1 output pulse. Zero may be represented by the ten pulses appearing at terminal 10, while the 11 and 12 pulse outputs may be used for control functions or for information transmission such as the identification of the calling telephone as a pay phone, and so forth.

Finally, after the appearance of an output pulse on terminal 1, the very next clock pulse from clock 16 will result in a "reset" signal on line 24 from driver starting unit 14 to reset number generator 12 to a non-active state where no output pulses are appearing on any of the terminals 1 to 12. Thus (as will be shown later in more detail), if a "start" signal on line 22 is repetitively generated after each "reset" signal on line 24, number generator 12 will repetitively and simultaneously produce the previously discussed plurality of output pulse trains with each individual train representing one possible value for the digit of a number.

While number generator 12 is useful in providing a plurality of output pulse trains for representing all of the possible values for any given digit of a particular number, additional means must also be provided for determining which particular ordinal place of the transmitted predetermined number is to be transmitted at any given instant in time. That is, there must be some priority means for determining the order of transmission of the pulse trains from number generator 12 such that the final series of pulse trains will respectively and sequentially represent the sequential digits of a particular predetermined number and thus be capable of providing the required meaningful output at a receiving terminal. This apparatus is shown in FIGURE 1 and is referred to as a digit priority determining unit 20, and is associated with counter 18 and driver starting unit 14 and, of course, driven by the same clock pulsese from clock 16 that are also used to drive number generator 12.

In the exemplary embodiment, the predetermined number of interest will be described as having twelve ordinal places. Thus, counter 18 must have at least twelve distinct states as, for instance, may be obtained by the use of at least four bistable stages in a binary digital counter. The counter 18 shown in FIGURE 1 is, however, not utilized for counting all the clock pulses from clock 16. Rather, counter 18 is effective for counting clock pulses and thus changing its state only when it receives a proper "enable" signal on line 26 from driver starting unit 14. As shown in FIGURE 1, this "enable" signal is taken from the same line which provides the "reset" signal on line 24 to number generator 12. Thus, counter 18 is only "enabled" to count an additional clock pulse at the end of each complete cycle of number generator 12.

Prority determining unit 20 comprises logic circuitry connected to counter 18 for sensing the instantaneous state of counter 18 and for producing a plurality of output signals on lines indicated at 50 to sequentially represent each of the ordinal places of the predetermined number having a total of twelve ordinal places (including control and information digits in addition to the usual telephone number) in the illustrative embodiment.

As will be more completely described below, when counter 18 completes a cycle of counting an "end cycle" signal on line 30 is transmitted to the driver starting unit 14 which works in a similar manner to the "end cycle" signal on line 32 (appearing on the next clock cycle after a pulse appears on the "1" terminal of number generator 12) from number generator 12 causing the counter to advance (by placing an additional "enable" signal on line 26) to its first state representing the first ordinal place of the predetermined number. Subsequently, a fresh "start" signal on the line 22 is generated to start the cycle of the number generator 12 all over again. At the end of this cycle, an "end cycle" signal on line 32 causes the driver starting unit 14 to produce another enable signal on the line 26 thereby causing the counter 18 to advance to its second state and subesequently resulting in another "start" signal on line 22 to initiate a second complete cycle for number generator 12. This automatic sequential and repetitive action of the counter 18 and pulse number generator 12 is continued until all of the twelve ordinal places of the predetermined number (represented by sequential signals on respective lines of a group represented in FIGURE 1 by a single line

50) have been transmitted, at which time the counter 18 rapidly advances through any remaining unused states until the beginning counter state, corresponding to the first ordinal place or digit, is reached whereupon another "start" signal is generated on line 22 to begin the whole process over again.

So far, the apparatus as described repetitively provides two groups of output pulse trains. One comes from the number generator 12 which repetitively and simultaneously produces a plurality of output pulse trains with each train representing one of the possible values of any given digit. The second comes from the priority determining unit 20 which produces another plurality of output pulses on lines 50 which respectively and sequentially represent the ordinal places of a predetermined number.

To utilize these two sets of pulse trains, individual output means forming the said selection units and each comprising a start/stop control unit 42 and an output unit 46, (as shown to the right of dotted line 10 in FIGURE 1) are provided for each of the telephone lines serviced by the common apparatus to the left of dotted line 10. Each of the output units 46 is permanently associated, as by a line 47, with a particular predetermined calling number which for the moment may be considered as connected through a switching apparatus to a particular called line. Each of the output means includes logic means for sequentially gating a selection, preset in that output means of particular pulse trains from number generator 12 in response to the sequential signals on lines 50 from priority determining unit 20 to sequentially represent ordinal places or digits of a number characterising that output means and the number of the associated calling telephone line.

A starting signal corresponding to "busy" signal on the called line or an unanswered called telephone may be introduced at 40 to start/stop control unit 42 which in turn causes a signal to appear on line 44 to a corresponding output unit 46 thus permitting output unit 46 to respond to the repetitive and sequential signals always present at lines 48 and 50 from number generator 12 and priority determining unit 20. Thus, when enabled by a signal on line 44, a particular output unit 46 is caused to transmit groups of pulses sequentially representing the digits of a particular predetermined number corresponding to the particular preset condition of the output unit 46.

As shown in FIGURE 1, a plurality of output units and start/stop control units are utilized in a complete system with a pair of such units being provided for each serviced telephone circuit.

Of course, the output pulses from the output units 46 may be used to operate a relay or other means to interrupt the telephone circuit if the recording aparatus to be used at the called equipment requires this. Actual transmission of the output electrical pulses along the telephone circuit may also be utilized in order to transmit the desired information to the called telephone site.

Briefly, referring now to FIGURE 2, some of the waveforms shown therein have already been implicitly explained and will therefore be meaningful at this point. For instance, the clock pulses shown at the top of FIGURE 2 represent the output from clock 16 while the signal represented by F/FS represents a signal on line 44 requesting the transmission of information on a particular one of the serviced telephone lines.

The waveforms represented at N1 and N2 represent two of the signals on respective lines of the group of lines 50 from priority unit 20 wherein N1 is "on" for a length of time corresponding to twelve cycles of clock pulses. As son as N1 turns "off", a signal N2 appears on another of lines 50 which follows the line carrying N1 in a sequence corresponding to the desired transmission sequence of digit values in the system. Of course, during the time N1 is "on", number generator 12 goes through a complete cycle and the output appearing on terminal 12 in FIGURE 1 is shown as INV12 in FIGURE 2 where 12 output pulses are shown during the time N1 is "on". Other outputs are shown for terminals 11 and 1. Likewise, when N2 is "on" a similar complete cycle of number generator 12 will occur and the first portion of that complete cycle is shown at the extreme right in FIGURE 2. Other waveforms shown in FIGURE 2 will be meaningful only after a discussion of the detailed circuitry used in the exemplary embodiment.

Referring now to FIGURE 3, the electronic pulse number generator 12 of FIGURE 1 is shown in more detail. In essence, the number generator comprises a series of flip-flops (which term is intended herein and in the appended claims to refer only to bistable circuits) FF12, FF11 . . . FF1 and associated logical input gates which primarily involve logical combinations of outputs from the various flip-flops. (In the drawings, a dot in a gate symbol represents an AND function and plus an OR function.) In addition, the number generator also includes a series of inverters INV12, INV11 . . . INV1 together with associated input logic circuitry which combines outputs from the various flip-flops with clock pulses CP from clock 16. The generator output terminals 12 through 1 shown in FIGURE 1 are shown here as the outputs of inverters INV12 through INV1 respectively.

A "reset" signal from line 24 is shown as connected to one input of each of the twelve

flip-flops FF12 to FF1 to simultaneously reset all of the flip-flops to a particular one of their bistable statese. For instance reset line 24 may be connected to all of the "O" inputs of the various flip-flops to simultaneously set all the flip-flop outputs to "O" in response to a "reset" signal on line 24.

As shown in FIGURE 3, the start signal on line 22 is connected to one of the inputs of FF12, for example the "1" input. Clock pulses CP are also introduced into each of the flip-flops and the actual transition from one stable state to the other occurs in response to these clock pulses as is well known in the art. Thus, after a start signal on line 22 is applied, the next clock pulse shifts flip-flop FF12 to a "1" output which is then transmitted to the input of the next succeeding flip-flop FF11 through "OR" gate such that on the occurrence of the next clock pulse FF11 is also shifted to the "1" state.

Although the output of FF12 should retain its "on" or "1" output condition since the "start" signal on line 22 is maintained until a "reset" signal appears on line 24, to ensure against accidental resetting of FF11, the output from FF11 is also admitted through "OR" gate 100 to the input of FF11 thereby providing a self-latching circuit to maintain FF11 with a "1" output until a "reset" signal is received on line 24.

The remaining flip-flops FF10 to FF1 are similarly and sequentially linked through "OR" gates 101, 102, 103, 104, 105, 106, 107, 108, 109 and 110. The output from FF1 also provides the "end cycle" signal on line 32 to the driver starting unit as previously discussed.

As shown in FIGURE 2, the output FF12 comprises a series of output pulses, each output pulse being equal in length to 12 clock pulse cycles. Similarly, the output FF11 corresponds to a series of pulses having a length equal to eleven clock pulses and FF1 has a length corresponding to one complete clock pulse cycle. All of the output signals FF12 to FF1 terminate at a common point in time determined by a common "reset" signal on line 24.

Each of these outputs FF12 to FF1 is then combined in "AND" gates 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126 and 127, respectively, with clock pulses CP. The output from these "AND" gates is presented to inverters INV12 to INV1 respectively to provide the previously discussed pulse trains having 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2 and 1 output pulse trains, respectively, with coincident terminal pulses in each of the trains occurring on terminals 12 to 1 respectively.

The output from INV12, INV11 and INV1 have been previously discussed with respect to FIGURE 2. The "start" signal on line 22 corresponds to waveform INVB shown in FIGURE 2 as the third waveform from the top. The "reset" signal on line 24 corresponds to INVA also shown in FIGURE 2. It should be noted that the "start" signal on line 22 and the "reset" signal on line 24 are related to one another in that each is the inverse of the other.

A suitable driver starting unit 14 is shown in more detail in FIGURE 4. In essence, this unit comprises an inverter INVA and another inverter INVB together with input logic circuitry comprising "AND" gate 150 together with "OR" gate 154. The "end cycle" signal on line 32 corresponding to the output from FF1 is forms an input to "OR" gate 154 while the "end cycle" signals on lines 30 corresponding to particular states of counter 18 are first combined in "AND" gate 150 in a particular manner that will be more apparent after the following discussion.

Whenever an "end cycle" signal is present at the input 32 to "OR" gate 154, INVA is turned "on" while INVB is turned "off." Thus, the output from INVA on line 26 may be used as a "reset" signal on line 24 for number generator 12 (as previously discussed) while the output from INVB may be utilized for a "start" signal on line 22 to pulse number generator 12 (as has also been previously discussed). The waveforms of INVB and INVA have already been discussed with respect to FIGURE 2 and the operation of the driver starting unit should now be apparent to those skilled in the art.

The counter 18 is shown in FIGURE 4 as a typical binary digital counter comprising four individual bistable flip-flop elements FFA, FFB, FFC and FFD connected together in a counting circuit. Normally, the input clock pulses at 160 would cause the counter to advance by one additional distinct state, (through each of its sixteen possible state) in a repetitive fashion each time a clock pulse is received on line 160. However, FFA is normally biased in such a way that the clock pulses are ineffective to cause flip-flop FFA to shift from one state to the other unless an "enable" signal on line 26 is present. As shown in FIGURE 4, the enable signal on line 26 is actually the output from INVA in the driver starting unit 14 and thus the "enable" signal for the counter corresponds to the "reset" signal for number generator 12.

Finally, the priority determining unit 20 is also shown in FIGURE 4. In essence, the priority determining unit comprises 12 drive circuits (hereinafter called drivers), DRIV No. 1 to DRIV No. 12 whose outputs respectively correspond to outputs N_1, N_2, N_3, . . . N_{12} which represent the 12 ordinal

places or digits of a predetermined telephone number plus control and/or extra information digits in this exemplary embodiment. Each of the drivers has an input gate 170, 172, 174 . . . 192 which utilize as inputs, the outputs from flip-flops FFA, FFB, FFC and FFD (or their inverted outputs).

Thus, the output from each of the "AND" gates 170 to 192 respectively corresponds to a particular distinct state of counter 18. For instance, an output will appear from gate 170 only when all of the flip-flops in counter 18 are "off" (which expression is used herein to mean that there is a signal on the output represented by a bar over the relevant output reference letter), corresponding to a particular distinct state of the counter and thus driving DRIV No. 1 and producing a signal at terminal N_1 corresponding to the time for transmitting a first digit of the predetermined number.

Subsequently, the next distinct state of counter 18 is represented by an "on" condition of FFA and an "off" condition of the remaining flip-flops in counter 18. Thus, as shown in FIGURE 4, "AND" gate 172 will have an output when the counter changes to this specific distinct state while none of the other "AND" gates have inputs corresponding to that same state. Thus, the output from gate 172 and from DRIV No. 2 on terminal N_2 corresponds to the time for transmitting a second digit of the predetermined number. A similar analysis holds with respect to the remaining 10 "AND" gates 174, 176, 178 . . . 192 and drivers shown in priority determining unit 20 in FIGURE 4. Since counter 18 has in fact 16 distinct states, the exemplary embodiment could be used to transmit predetermined numbers up to 16 digits or ordinal places in length. However, as described below, only 12 of the distinct states of counter 18 are actually utilized in this exemplary embodiment for transmitting digits. This allows some economy in the number of inputs to gates 174 to 192. The remaining four unused counter states are effectively bypassed by holding the enable signal on line 26 "on" (and thus the "reset" signal on line 24 to number generator 12) for four consecutive clock cycles thus permitting the counter 18 to quickly cycle through the four unused distinct states to ready the apparatus for another repetitive cycle.

The means for insuring this quickened cycling of counter 18 through the unused counter states comprises "AND" gate 150 in driver starting unit 14. As shown in FIGURE 4, the uninverted output from FFC and that from FFD are fed over lines 30 and combined in "AND" gate 150. Thus, any counter state corresponding to an "on" condition of FFC and FFD will cause a continuing "reset" and "enable" signal from unit 14.

As shown in FIGURE 4, the input to "AND" gate 150 comprises the ouput from flip-flops FFC and FFD. The mechanism involved will be readily apparent if one considers for a moment the sixteen successive states of counter 18, as follows.

If the uninverted outputs A, B, C and D from flip-flops FFA to FFD respectively are represented by the usual numerals "0" and "1", and a starting point where all the four flip-flops are in an "off" condition is assumed, the successive states of the counter stages are shown as follows with the corresponding associated ordinal digit of the predetermined number being indicated in parenthesis: 0000(1); 1000(2); 0100(3); 1100(4); 0010(5); 1010(6); 0110(7); 1110(8); 0001(9); 1001(10); 0101(11); 1101(12); 0011(none); 1011(none); 0111(none); 1111(none). The four counter states to be disregarded 0011, 1011, 0111 and 1111 will be bypassed since the outputs from flip-flops FFC and FFD will be combined in "AND" gate 150 to provide an "end cycle" signal through "OR" gate 154 thus producing a "reset" and "enable' signal at the output from INVA and thus causing the counter to step on successive clock pulses past these four states, instead of stepping only once upon every cycle of generator 12.

Suitable start/stop control units 42 and output units 46 shown in FIGURE 1 are shown in more detail at FIGURE 5. Throughout the following discussion, it should be kept in mind that the apparatus shown in FIGURE 5 is repeated for each of the telephone lines served by the apparatus of this embodiment.

The start/stop control unit 42 comprises a bistable flip-flop FFS having non-inverted output S and an inverted output $\bar{S}$. Normally, flip-flop FFS is biased insensitive to any input on line 200 coming from inverter INVE. However, this bias of the input against response or chang of state may be altered by a "start" input on line 202 originating from a called line associated with this particular start/stop unit. For instance, the "start" signal on line 202 may be generated automatically in response to a busy signal coming from a called line or failure to answer a ringing signal sent from the calling telephone site to the called telephone site.

As previously discussed, the starting time point for the first ordinal place of the predetermined number corresponds to a state 0000 of counter 18. In order to start the serial transmission of pulse trains corresponding to the digits of predetermined number at a proper starting point, the output means 46 must be enabled or sensitized as

previously discussed by a signal on line 44 from unit 42 at a proper point just prior to the starting of another complete cycle of the priority determining unit 20.

As shown in the illustrative embodiment in FIGURE 5, this is conveniently accomplished by combining the outputs of flip-flops FFA to FFD in "AND" gate 204 such that an output from "AND" gate 204 occurs sometime during the "dead time" in which counter 18 is being quickly cycled through the four unused counter states. As shown in FIGURE 5, this occurs for counter state 1011 which is just two states removed from the beginning point of 0000. Accordingly, whenever a start signal from the called telephone line on line 202 is present, flip-flop FFS will be enabled to flip upon the next signal from line 200 which will occur the next time counter state 1011 occurs just prior to another complete cycle of priority determining unit 20. When this finally occurs, an output signal from flip-flop FFS is transmitted along line 44 to a corresponding output unit 46.

The output unit 46 is also connected to the number generator 12 by lines 48 and to the priority determining unit 20 by lines 50. Unit 46 essentially comprises a plurality of "AND" gates 250, 252, 254 . . . to 274 (one for each of the twelve ordinal places or digits of the predetermined number) with the outputs from each of these "AND" gates being combined in "OR" gate 262 before amplification by driver 264 for ultimate transmission at the output of driver 264 on the called line for recording at the called telephone site.

Thus, as shown in FIGURE 5, the output N_1 from the priority determining unit is combined in "AND" gate 274 with an enable signal S from start/stop control unit 42 and a pulse train comprising twelve pulsese from the output of INV12 (corresponding to a digit value of 12 for the first ordinal place of a particular predetermined number) is output from driver 264 during the time interval for transmitting the first digit as indicated by N_1. Corresponding analysis for each signal N_1 to N_{12} shows that, for the example shown in FIGURE 5, the value of the third ordinal place or digit equals 2; the value of the eighth ordinal place or digit equals 10 and the value of the ninth ordinal place equals 5, etc. Thus, as the counter now cycles from state 0000 consecutively through to state 1101 the twelve digit values for the 12 place predetermined number are sequentially transmitted over the called telephone line as a series of pulse trains, each train having a number of pulses representing a particular value for that particular ordinal place of the predetermined number. The next time counter state 1011 occurs corresponding to an output from "AND" gate 204, the output from inverter E on line 200 will cause flip-flop FFS to turn "off" thus inhibiting any further transmission from output unit 46 since the enabling signal S is no longer present at each of the "AND" gates 250, 252, 254 . . . 274.

Thus, a complete cycle of operation involves receiving a "start' 'signal from the called line on line 202 at a particular start/stop control unit 42 which in turn causes the transmission of an enabling signal S on line 44 the next time counter state 1011 is attained in counter 18. Subsequently, the corresponing output unit 46 is enabled to sequentially transmit groups of pulse trains corresponding to the digital values of the ordinal places of a predetermined telephone number (preset in output unit 46 by a particular connection of outputs from number generator 12 and priority determining unit 20 in "AND" gates 250 to 274 and finally terminating the next time counter state 1011 is sensed by "AND" gate 204.

For each of the subscribers of a particular telephone exchange, an individual output unit 46 is provided, and, for purposes of explanation, the above exemplary description has been given assuming the additional presence of one flip-flop FFS for each of the subscribers. In reality, the functions of start/stop control unit 42 may be performed with only one flip-flop FFS for each first stage of a telephone exchange, thus saving a large number of circuits as will be apparent to those skilled in the art. Such a driver individual in the first stage of a telephone exchange has a number of two leg input 'AND" gates with a number of such gates depending upon the particular requirements of the telephone exchange under consideration as will be apparent to those skilled in the art.

A typical detailed electrical circuit for use in the number generator of FIGURE 3 is shown in FIGURE 6. The "AND" gate 116 and "OR" gate 100 as well as inverter INV12 and flip-flops FF12 and FF11 are shown in detail. The operation of these circuits is obvious to one skilled in the art and is shown only for purposes of illustration and therefore will not be further discussed.

Similarly, the specific electrical circuitry shown in FIGURE 7 is a typical circuit which may be used in the driver starting unit 14 shown in FIGURE 4. "OR" gate 154 and "AND" gate 150, as well as inverters INVA and INVB are shown only for purposes of illustration. It will be readily appreciated by those skilled in the art that there are many other circuits which could be just as easily used in the apparatus previously described.

In a similar manner, the specific elec-

trical circuitry shown in FIGURE 8 may be used in the priority determine unit 20 shown in FIGURE 4. Here, "AND" gates 170 and DRIV No. 1 are shown in detail. The operation of this circut will be readily appreciated by those skilled in the art and no detailed explanation is believed to be necessary. It will also be readily appreciated by those skilled in the art that other equivalent circuitry may be readily substituted for that shown in FIGURE 8.

The specific circuitry shown in FIGURE 9 may be used for an output unit 46 such as shown in FIGURE 5. As shown in FIGURE 9, such an output unit may in fact comprise a series of two legged gates such as gate 250 which drive an intermediate driver 253 which is, in turn, connected to one of a series of three legged gates such as 254, where the enabling signal S is thus effectively combined with all the previous two legged gates prior to the intermediate driver. Alternatively, a plurality of all three legged "AND" gates could, of course, be used. The operation of the circuit of FIGURE 9 will be apparent to those skilled in the art and thus no further discussion is necessary. As shown in FIGURE 9, this paritcular output unit is preset to transmit the predetermined number (12)02137205109 representing a 12 digit number including a control digit (i.e., value 12), an area code (i.e., 021); an information code (i.e., 3, indicating a pay phone) and a 7 digit phone number (i.e. 720-5109).

Although only one embodiment of this invention has been specifically described in the foregoing description, it will be obvious to those skilled in the art that many modifications of the disclosed apparatus are possible while yet retaining all of the significant functions and hence operation of the overall apparatus as described above. For instance, integrated circuits could easily be substituted for many of the discrete element circuits shown in the illustrative embodiment.

WHAT I CLAIM IS:—

1. Pulse train generating and selection apparatus suitable for use in a telecommunication exchange system for passing data characteristic of a calling line to a selected called line, and including common pulse generator means for producing a plurality of pulse trains, each train representing one possible item of said data, and further means including a plurality of selection units, for association with respective calling lines, associated with the generator means so that each unit when operated can automatically select a particular predetermined sequence of said pulse trains, which is characteristic of that unit in order thus to be said data characteristic of the respective calling line.

2. Apparatus as claimed in claim 1, in which the pulse generator means are arranged for repetitively and simultaneously producing said plurality of trains on respective channels.

3. Apparatus as claimed in claim 1 or 2, in which said selection units are arranged to pass said sequences of pulse trains.

4. Apparatus as claimed in any preceding claim, in which each said selection unit includes gate means for selecting and passing its said characteristic sequence of pulse trains.

5. Apparatus as claimed in any preceding claim, suitable to pass data additional to said sequences and under the control of said selection units.

6. Apparatus as claimed in any preceding claim, in which there is equipment for selecting a calling line to cause eventual connection of a said selection unit to a selected called line.

7. Apparatus as claimed in any preceding claim, suitable for use in a telephone exchange system.

8. Apparatus as claimed in any preceding claim, adapted for said items to be digits and said characteristic data to be the directory number of the calling line.

9. Apparatus as claimed in any preceding claim, in which each selection unit is connected to a respective telecommunication line.

10. Apparatus as claimed in any preceding claim, including a clock means for producing electrical clock pulses to drive said pulse generator means, and control ordinal timing of a said sequence.

11. Apparatus as claimed in any preceding claim, with a clock pulse input wherein said pulse generator means comprises:

a plurality of serially connected flip-flops (as hereinbefore defined) for sequentially flipping to a predetermined stable state and remaining thereat in response to sequential clock pulses from said clock pulse input,

an "AND" gate, having at least two inputs and an output, and being respectively associated with each of said flip-flops,

one of said "AND" gate inputs being connected to at least one output of its respectively associated flip-flop for producing a gating input to the "AND" gate whenever its associated flip-flop is in said predetermined stable state, and

the other of said "AND gate inputs being connected to said clock pulse input thereby providing a train of clock pulses at the "AND" gate output whenever said gating signal is present from its respectively associated flip-flop.

12. Apparatus as claimed in claim 11, wherein:

each of said flip-flops includes a first and a second input for causing the associated flip-flop output to take on a respectively

corresponding one of first and second stable states upon the next clock pulse occurrence,

said first input of the first of said serially connected flip-flops being connected to a start terminal for beginning a complete cycle of said sequential flipping, and

an output of the last of said serially connected flip-flops being connected to an end cycle terminal for signalling the end of said complete cycle.

13. Apparatus as claimed in claim 12, including a reset line commonly connected to all of said second inputs of said plurality of flip-flops for simultaneously resetting all of said flip-flops to said second stable state upon the next clock pulse occurrence.

14. Apparatus as claimed in any preceding claim, wherein said pulse generator means is arranged to produce one complete cycle of said pulse trains in response to a start signal and produce an end cycle signal upon the completion of said complete cycle, said apparatus further including a driver starting unit comprising:

input means for receiving said end cycle signal,

first inverter means having an ouput and having an input connected to said input means,

second inverter means having an output and having an input connected to the output of said first inverter,

the output from said first inverter being effective to provide a reset signal for resetting said pulse generator to an inactive state characterized by the absence of output signal from said pulse generator, and

the output from said second inverter being effective to provide said start signal

15. Apparatus as claimed in any preceding claim, in which said further means include a common unit associated with said selection units for ordinally controlling the time of occurrence of said pulse trains in a said sequence.

16. Apparatus as claimed in claim 15, wherein said ordinal control unit has a clock pulse input and comprises:

a digital counter having a plurality of binary stages for counting pulses input thereto,

said counter being connected to said clock pulse input of the unit but being normally inhibted from counting in response to clock pulses therefrom unless an enabling signal is also present, and

a plurality of logic gates, each having an output and at least one input connected to at least one of said binary stages for generating, for the ordinal timing control, sequential ordinal place signals at outputs of said logic gates in correspondence with sequential changes in the contents of said digital counter.

17. An apparatus as claimed in claim 16, including means for resetting said pulse generator means to a non-active state at the end of a complete cycle of said pulse trains and wherein said means is also effective to simultaneously produce said enabling signal for said digital counter.

18. Apparatus as claimed in any preceding claim, wherein each said selection unit comprises a starting unit arranged to enable the selection unit only for complete transmission cycles of said sequence appertaining thereto.

19. Apparatus as claimed in any preceding claim, wherein each said selection unit comprises:

a starting unit for producing an output request signal,

a plurality of "AND" gates with inputs operatively connected to receive said output request signal, and to receive preset ones of said pulse trains from said pulse generator means, to provide its said sequence of pulse trains, and

"OR" gate means for effectively combining the gated output from all of said "AND" gates onto a single output line.

20. Apparatus as claimed in claim 19 when appendant to claim 15, wherein said "AND" gates of the selection units have inputs operatively connected to receive preset ordinal place signals generated by the ordinal control unit, and each said starting unit comprises:

a flip-flop which normally does not change its state unless enabled by a start signal, and

input means connected to said ordinal control unit for sensing the incipient beginning of a cycle of said ordinal place signals, for causing this flip-flop to change states and produce said output request signal if said start signal is present and for causing said flip-flop to change states and remove said output request signal at the next sensing of said incipient beginning.

21. Pulse train generating and selection aparatus substantially according to any embodiment hereinbefore described with reference to the accompanying drawings.

22. A telecommunication exchange operatively incorporating apparatus as claimed in any preceding claim.

23. A telecommunication system including subscriber equipments and operatively incorporating apparatus as claimed in any one of claims 1 to 21.

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1362412 COMPLETE SPECIFICATION

6 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

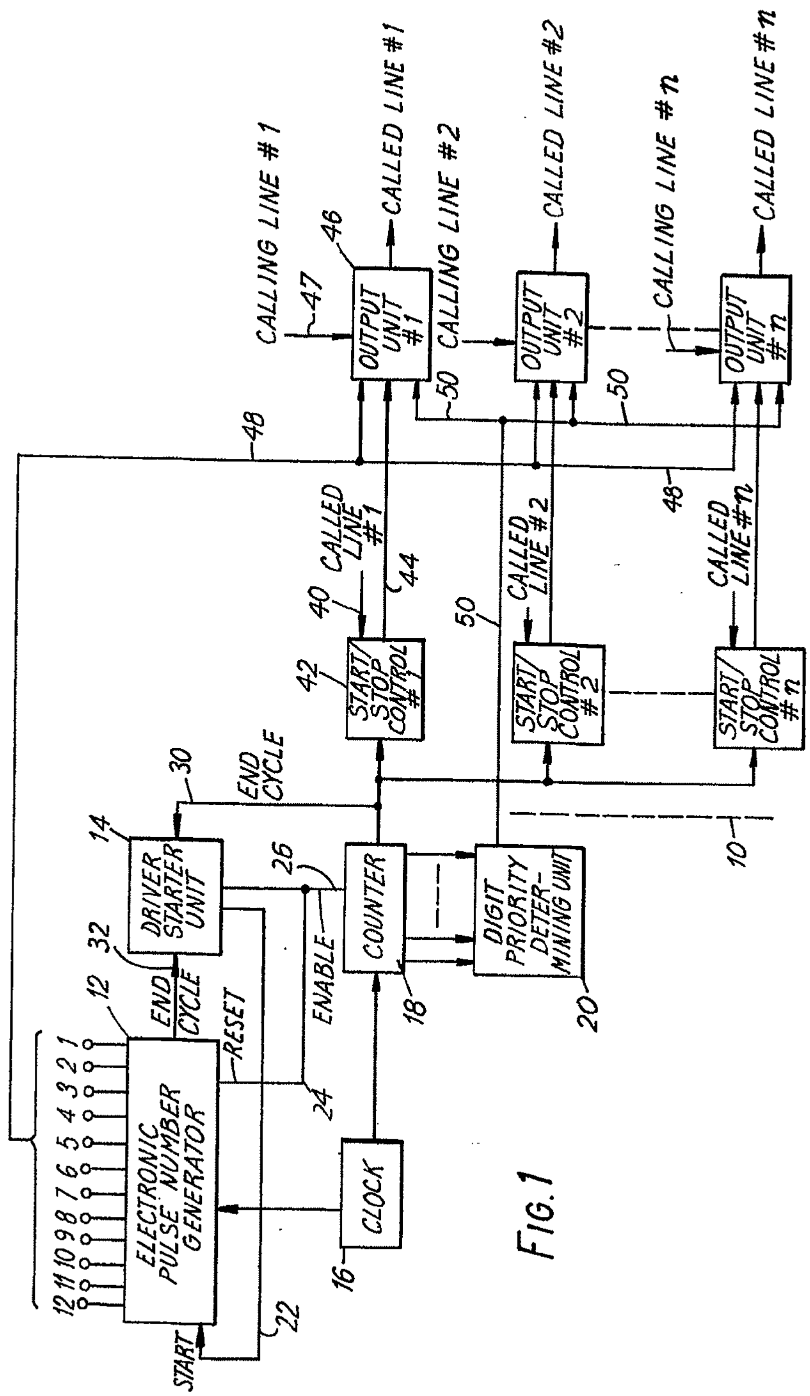


FIG. 1

FIG. 2

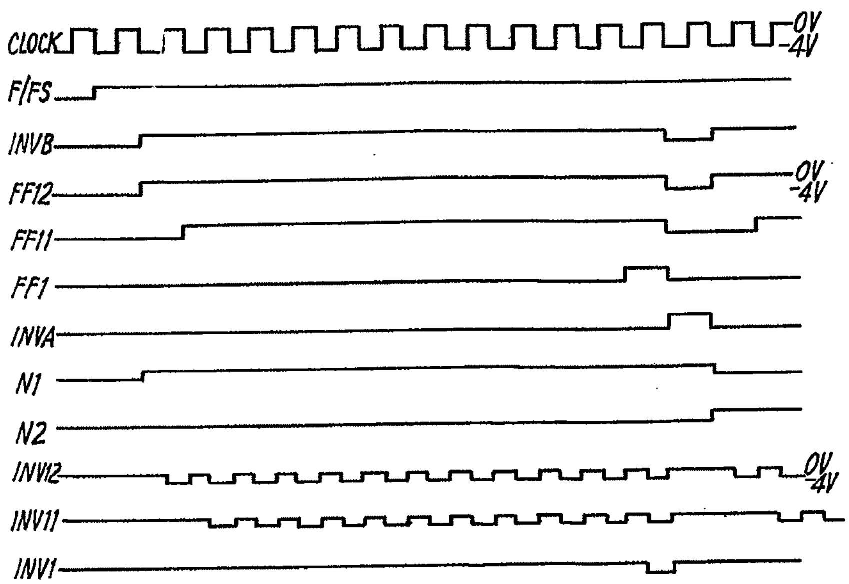
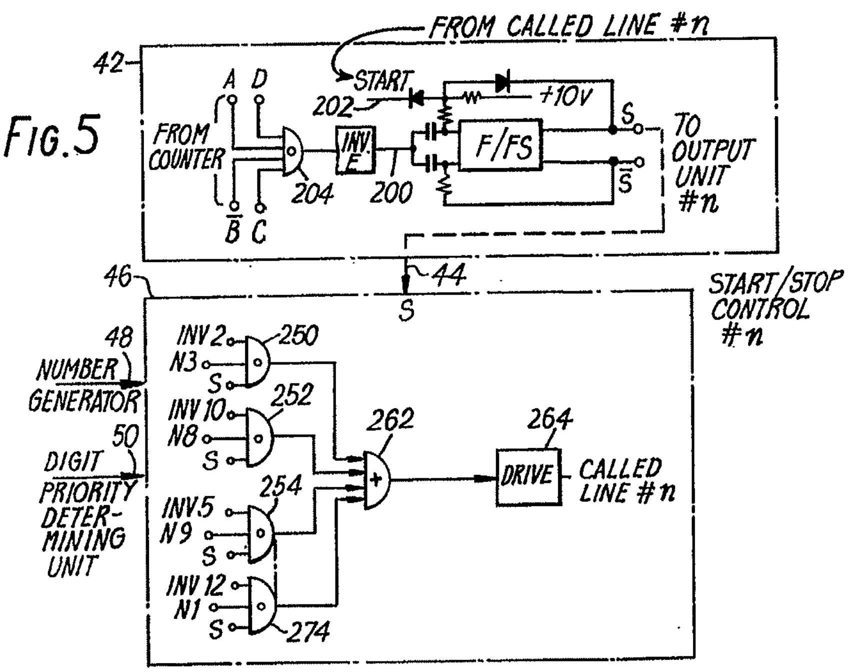

CLOCK
0V
-4V
F/FS
INVB
FF12
0V
-4V
FF11
FF1
INVA
N1
N2
INV12
0V
-4V
INV11
INV1

FIG. 5


FROM CALLED LINE #n
42
A D
START
202
+10V
FROM COUNTER
INV E
F/FS
S
S̄
TO OUTPUT UNIT #n
204
200
B̄ C
46
44
S
START/STOP CONTROL #n
48
NUMBER GENERATOR
INV 2
N3
S
250
INV 10
N8
S
252
262
264
DRIVE
CALLED LINE #n
50
DIGIT PRIORITY DETER-MINING UNIT
254
INV 5
N9
S
INV 12
N1
S
274

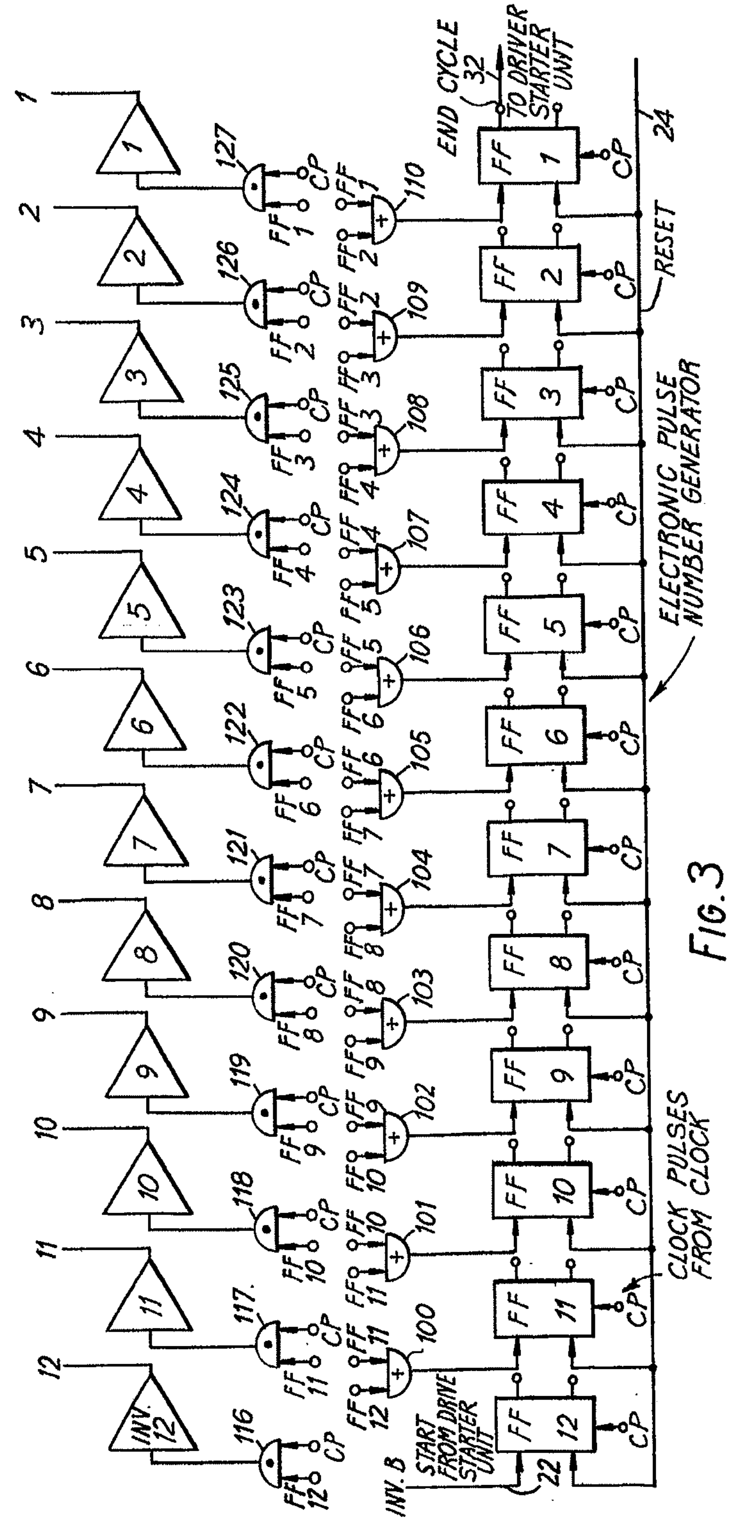

END CYCLE
TO DRIVER STARTER UNIT
RESET
ELECTRONIC PULSE NUMBER GENERATOR
CLOCK PULSES FROM CLOCK
START FROM DRIVE STARTER UNIT
INV. B

FIG. 3

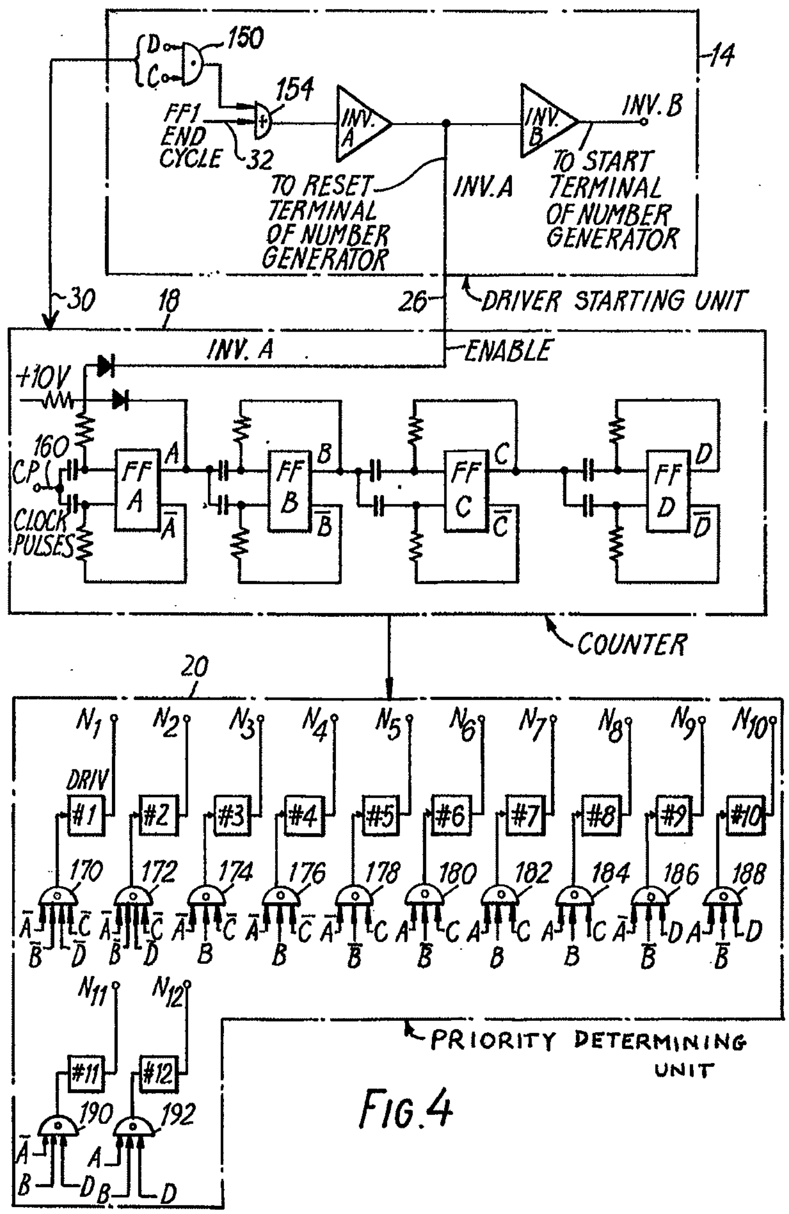

D
C
150
14
154
FF1 END CYCLE
32
INV. A
INV. B
INV. B
TO RESET TERMINAL OF NUMBER GENERATOR
INV. A
TO START TERMINAL OF NUMBER GENERATOR
30
18
26
DRIVER STARTING UNIT
INV. A
ENABLE
+10V
160
CP
CLOCK PULSES
FF A
FF B
FF C
FF D
COUNTER
20
DRIV
170
172
174
176
178
180
182
184
186
188
190
192
PRIORITY DETERMINING UNIT

FIG. 4

FIG.6

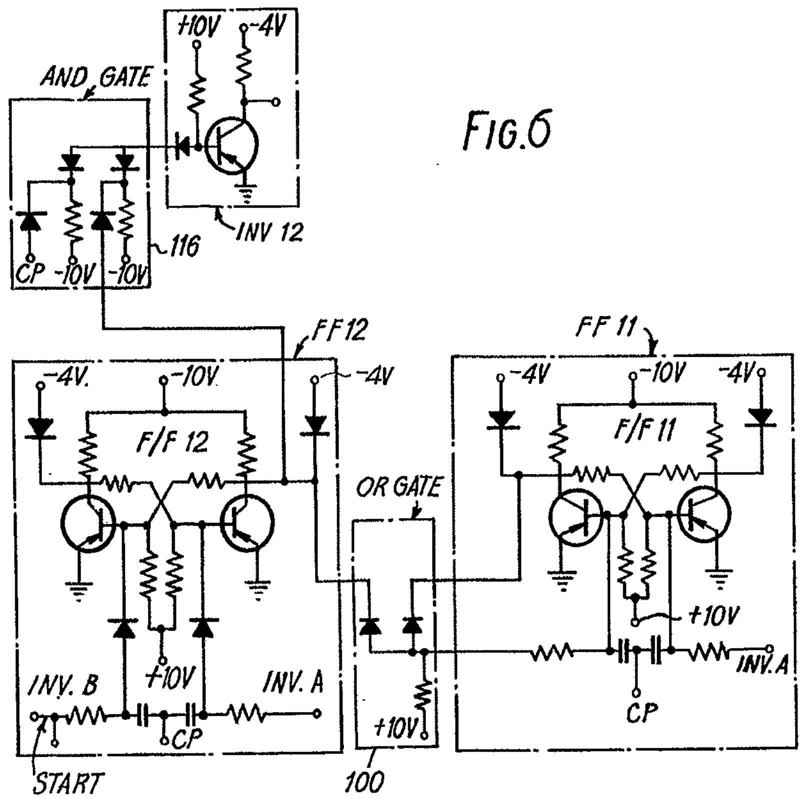
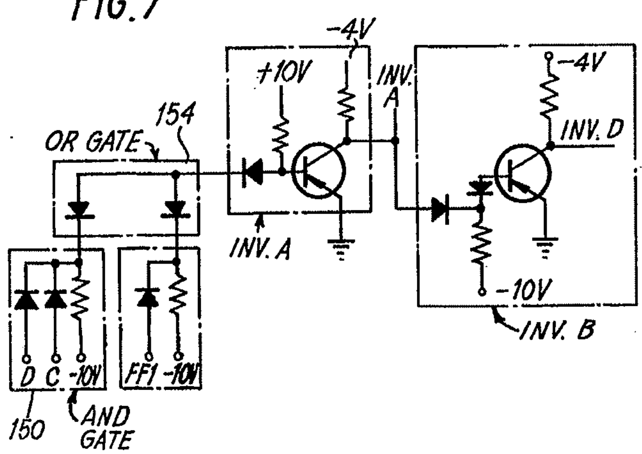

AND GATE
+10V
-4V
INV 12
116
CP
-10V
-10V
FF 12
-4V.
-10V.
-4V
F/F 12
+10V
INV. B
INV. A
CP
START
OR GATE
+10V
100
FF 11
-4V
-10V
-4V
F/F 11
+10V
INV. A
CP

FIG.7


154
OR GATE
+10V
-4V
INV. A
INV. A
-4V
INV. D
-10V
INV. B
D
C
-10V
FF1
-10V
150
AND GATE

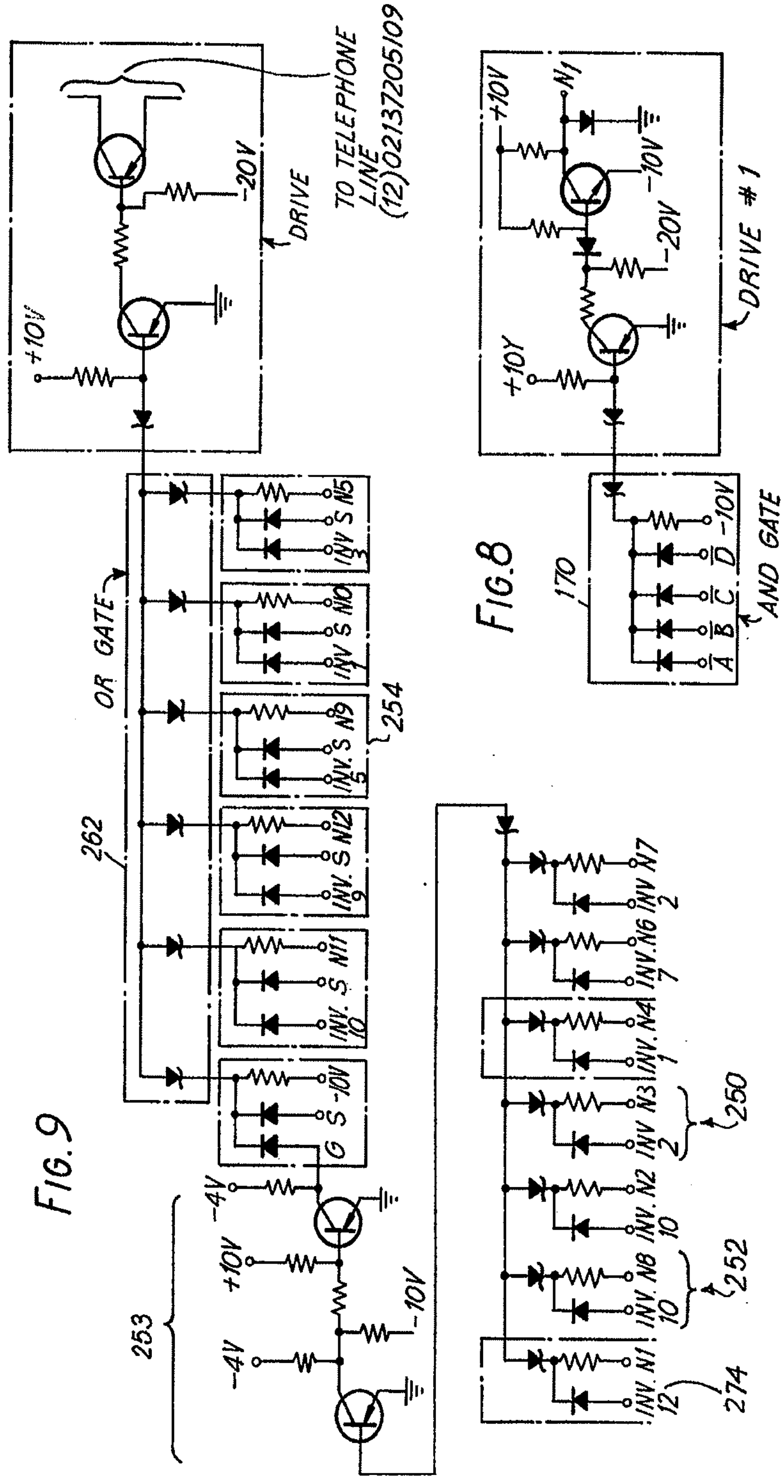

AND GATE
170
DRIVE #1
+10V
-10V
-20V
A B C D
TO TELEPHONE LINE (12)02137205109
DRIVE
OR GATE
262
254
250
252
253
274
-4V

FIG.8

FIG.9